1- The mattress of a water bed is 2.00 m long by 2.00 and 30.0 cm deep.
(A) Find the weight of the water in the mattress.
B) Find the pressure exerted by the water on the floor when the bed rests in its normal position. Assume that the entire lower surface of the bed makes contact with the floor.

A)

$$M = \rho V = (1\,000\ \text{kg/m}^3)(1.20\ \text{m}^3) = 1.20 \times 10^3\ \text{kg}$$

and its weight is

$$Mg = (1.20 \times 10^3\ \text{kg})(9.80\ \text{m/s}^2) = 1.18 \times 10^4\ \text{N}$$

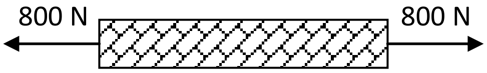
B) When the bed is in its normal position, the area in contact with the floor is 4.00 m^2 ,thus,

$$P = \frac{1.18 \times 10^4\ \text{N}}{4.00\ \text{m}^2} = 2.95 \times 10^3\ \text{Pa}$$

Example

The bar shown has a square cross section for which the depth and thickness are 40 mm. If an axial force of 800 N is applied along the centroidal axis of the bar's cross sectional area, determine the average normal stress acting on the bar ?

$$\sigma = \frac{F}{A} = \frac{800}{(40*10^{-3})^2} = 500*10^3\ \text{Pa}$$



Example:

A wire of length 120cm and diameter 0.82mm, supported from one end, A 5.3kg in the other end . Find :

a) The stress in the wire

b) The strain in the wire

c) The strain energy where $Y = 1.2\text{x}\ 10^{12}\ \text{dyne/cm}^2$ ***and*** $g = 980\text{cm/sec}^2$

Solution

$r = \frac{0.82}{20} = 0.041\,cm$ and $m = 5.3x10^3 gm$

$The\ stress = \frac{F}{A} = \frac{m\ g}{A} = \frac{\left(5.3x10^3\right)980}{\pi\left(0.041\right)^2} =$ $dyne/cm^2$

$The\ strain = \frac{Stress}{Y} =$

$$Strain\ Energy = \frac{1}{2}\left(Stress\right)\left(Strain\right) =$$

Example 2 :

A uniform wire of length 20cm density 0.78gm / cm^3 and mass 16gm stretched by a distance 1.2mm when 8kg is supported on it , Find :

- ***a) The stress in the wire***
- ***b) Young's modulus***
- ***c) The strain energy***

Solution

$Volume\ V = \frac{m}{\rho} = \frac{16}{7.8} = 2.05\,cm^3$

$But\ V=A\,.\,L \Rightarrow A = \frac{V}{L} = \frac{2.05}{20} = 0.1\,cm^2$

$Stress = \frac{F}{A} = \frac{m\ g}{A} = \frac{\left(8x10^3\right)980}{0.1} =$ $dyne/cm^2$

$But\ Stress = Y\frac{\Delta L}{L} \Rightarrow Y = \frac{Stress\ .\ 20}{1.2x10^{-1}} =$ $dyne/cm^2$

$$Strain\ Energy = \frac{1}{2}\left(Stress\right)\left(Strain\right) =$$

Example :

An aluminum cylinder 10cm long with cross-sectional of 20cm^2 is to be used as a spacer between two steal walls. At 17.2^{o}C it just slips in between the walls. Then it warms to 22.3^{o}C. Calculate the stress in the cylinder and the total force it exerted on each wall and the strain energy .

Where ($\alpha = 2.4x10^{-5^o} K^{-1} \quad , \quad Y = 7x10^{10}\ N/m^2$ ***)***

Solution

Stress

$$= \frac{F}{A} = Y\ \alpha\ \Delta T = \left(7x10^{10}\right)\left(2.4x10^{-5}\right)\left(22.3 - 17.2\right) = 8.6x10^{6}\ N/m^2$$

The total force on each wall

$$F = (A)(Stress) = \left(20x10^{-4}\right)\left(8.6x10^{6}\right) = 1.7x10^{4}\ N$$

$$Strain\ Energy = \frac{1}{2}(Stress)(Strain)$$

But Stress $= Y\ (Strain)$